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DATA ON THE RELATIVE CONSPICUOUSNESS OF BARRED AND SELF-COLORED FOWLS¹

DR. RAYMOND PEARL,

MAINE AGRICULTURAL EXPERIMENT STATION

I. PHYSICAL DATA

THE purpose of this note is to put on record a rather striking physical fact, and to discuss briefly its biological significance. Some two years ago Davenport² published a short note regarding the relative number of self-colored and of "penciled or striped" chicks killed by crows one afternoon, at Cold Spring Harbor. The rather striking result was that out of 24 birds killed, only one was other than self-colored. The communication closes with the following words: "This fragment, then, so far as it goes, indicates that the self-colors of poultry, which have arisen under domestication, tend to be eliminated by the natural enemies of these birds, and the pencilled birds are relatively immune from attack because relatively inconspicuous."

Some photographs taken on the poultry range of the Maine Experiment Station this past summer illustrate this point made by Davenport as to the relative conspicuousness of self-colored birds in so striking and complete a manner as to warrant their publication and a critical discussion of their significance. These photographs were made without any thought whatever at the time that they were going to bring out the relative conspicuousness of different plumage patterns. Indeed, it was not realized that they did so until the finished prints were given to me by the station photographer, Mr. Roy-

¹ Papers from the Biological Laboratory of the Maine Experiment Station, No. 23.

² Davenport, C. B., "Elimination of Self-Coloured Birds," *Nature*, Vol. 78, p. 101, 1908.



FIG. 1. Photograph of a Golden Pencilled Hamburg ♂. Practically a solid colored bird (red on body, black tail). The few barred feathers which the ♂ of this variety has are covered by solid colored feathers. In this picture one barred feather shows in the region of the saddle. The wind had displaced this feather.

den Hammond, to whom I am indebted for developing and printing these pictures. As a matter of fact the four pictures which accompany this note were taken for the purpose of (*a*) testing a then new camera as to its usefulness in obtaining pictures to form part of a permanent record system in poultry-breeding experiments, and (*b*) to get photographic records of certain particular birds of interest from one standpoint or another. All the exposures were made by the same person (the writer) on the same afternoon and within an hour of each other. It was on a cloudless afternoon early in August, and the light conditions, shutter-opening, speed, and diaphragm opening were constant for all of the pictures. What differences appear in the pictures, then, are such as are referable to the different color patterns of the birds, when seen under the light conditions and against the kind of background which obtained in this case.



FIG. 2. A very dark, practically solid black F_2 ♂ from the cross Cornish Indian ♂ × Black F_1 ♀ from Cornish Indian ♂ × Barred Rock ♀.

From these photographs the following points are to be noted:

1. As compared with self-colored birds the barred individuals obviously are relatively much less conspicuous, when under the same light conditions, and when seen against the same kind of a background. The pictures of the barred birds (Figs. 3 and 4) are not, to be sure, like the "puzzle" pictures of supposedly protectively colored organisms, which one sometimes sees, where it is exceedingly difficult to distinguish the animal from the background at all. In both Figs. 3 and 4 it is easy enough to see the bird, but at the same time these birds are obviously much less conspicuous than those shown in Figs. 1 and 2.

2. This inconspicuousness is equally marked whether the barred bird is in the bright sunlight (Fig. 3) or in a relatively deep shadow (Fig. 4).

3. These pictures furnish objective and unbiased phys-



FIG. 3. An F_2 barred cross-bred chick. Sex ♀. Produced by mating F_1 barred cross-breds *inter se*.

ical evidence regarding the relative conspicuousness of two types of plumage pattern.

II. DATA ON THE BIOLOGICAL VALUE OF THE INCONSPICUOUSNESS OF THE BARRED PATTERN

The physical fact set forth above is obvious: barred chickens are clearly less conspicuous than self-colored when seen against the background of grass on the range where they live. Has this physical fact any biological significance? Are the barred birds, by virtue of the possession of this color pattern, at any advantage in the struggle for existence? Is their relative inconspicuousness any real protection against their natural enemies? It is the purpose of this section of the paper to present some numerical data regarding this matter.

The only evidence which exists in the literature on this problem, so far as poultry is concerned, consists in the admittedly fragmentary statistics presented by Davenport, which have been cited above. It should be pointed



FIG. 4. A pure Barred Plymouth Rock ♀, with barring of fine quality from the fancier's standpoint. It is to be noted that the bird in this figure is in the shadow of a building in contrast to that shown in Fig. 3, which is standing in the bright sun.

out that Davenport's data are fragmentary not alone in respect to the small number of deaths (eliminations in the technical sense) involved, but also because these deaths were due to but a single one of the natural enemies of poultry, namely the crow. There are, of course, many others. Under the conditions prevailing on or about the poultry plant of which the writer has charge the following animals are regular or occasional destroyers of young chicks: Rats, skunks, foxes, crows, hawks, cats.³

In different seasons the relative importance of these different enemies varies. Thus in the breeding season of 1908 many birds were killed by foxes. In 1909, the year

³ To this list one feels tempted to add that species of vermin which is in some respects the worst which attacks a poultry plant, namely the thief, but fortunately the *range* was free from his depredations in 1909.

for which statistics are given below, not a single bird was killed by a fox so far as is known. Similarly in 1909 no birds were killed by skunks. In 1910 a skunk succeeded in getting into a house one night and killed a number of birds. On the Maine Station plant normally predaceous birds undoubtedly rank first in destructiveness. This is probably quite generally true of poultry plants, though because of the fact that the loss is distributed so evenly over the whole season the importance of this class of enemies is apt to be underrated. Next to predaceous birds stand rats, under our conditions. An important point to be noted is that on the plant under discussion here all killing of chickens by rats is done in the daytime. Rats burrow in the ground under the houses, and then when the chicks are playing about a rat will dash out, seize a chick and carry it back to the burrow. It is not an uncommon occurrence for a rat thus to kill as many as 12 chickens within the space of an hour. With rare exceptions we never lose any chickens at night except those taken by thieves. The chicks are shut and locked in rat and (usually) vermin proof houses at night. Occasionally, as noted above, a skunk is able to effect entrance into a house. This, however, did not happen in 1909, the year which furnished the statistics given below. It should be clearly understood that in the statistics which follow all "eliminations" occurred in the daytime, when color and pattern might presumably be of some significance.

It is my purpose to present some statistics, involving a relatively large number of individuals, regarding the relation of color pattern to the elimination of chickens by all of these natural enemies taken together. These statistics cover the hatching season of 1909 in which chickens were on the range, and subject to the attacks of enemies, from about April 1 to October 1. Birds of all colors and patterns ran together on the same open, turf-covered range, and, without regard to color or pattern, all were equally exposed to attack by all sorts of

natural enemies. The total number of chickens involved was 3,343. An account of the way in which the statistics were obtained is necessary. All of these 3,343 chicks were of known pedigree, and a numbered aluminum leg band was attached to each one when it was removed from the incubator in which it was hatched. A record was made of each chick's number. This numbered leg band was worn by the chick throughout its life. Whenever a chick died a record of this fact was made opposite its entry in the pedigree book. During the season every living chick on the range was handled over twice and its leg band number checked back with the original entry, and at the end of the season all chicks remaining on the range were checked up.

Now it is clear that dead chicks which come to autopsy will fall into two general classes: on the one hand, those that died from one or another of the many *diseases* which make the poultry raiser's life a burden in the springtime, and on the other hand, those *killed by some enemy but not carried away*. In the latter class will fall the great majority killed by rats, some killed by skunks, and a fair proportion of those killed by foxes. Usually a direct record can be obtained for practically none of the chicks killed by predaceous birds and cats. In 1909 we have reason to believe that substantially all unrecorded deaths were caused by predaceous birds.

At the end of the season when the birds are checked up all will be accounted for as either (*a*) living, (*b*) dead from some disease, (*c*) killed by recorded enemies, or finally (*d*) missing. Of the missing birds there are two classes again. On the one hand are those killed by enemies which carried the carcasses away, and on the other hand, are those that through accident lost their leg bands, and hence, while present in the flock, can not be entered upon the records. With the methods of work in use here the number of the latter class has always been small. Unfortunately I am not able to give exact figures for such birds for the season of 1909. It can be stated with cer-

tainty, however, that they did not exceed 25. Of this number that lost their leg bands 8 were known to be self-colored birds.

There were on the range in 1909 three classes of birds, in respect to color pattern. These were (*a*) barred birds, bearing either the pattern of the pure Barred Plymouth Rock, or a modification of it;⁴ (*b*) solid (self-colored) black birds, resulting from the cross Cornish Indian Game ♂ × Barred Rock ♀; and (*c*) pure Cornish Indian Games of the dark variety which may for present purposes be classed as self-colored birds.

With this somewhat lengthy explanation of the composition of the flock and method of keeping records in hand we may proceed to examine the statistics of elimination. In compiling these statistics the blank birds which lost their bands (ca. 25) have been included with the eliminated. This does not affect the conclusions in any way because of the facts that (1) the number of such birds is so small relatively, and (2) the proportion of self-colored to barred birds among those which lost their bands is relatively higher than in the general population from which they came. The significance of this point will be apparent as we proceed.

We have the following figures, it being understood that "eliminated" means "killed by natural enemies" with the inclusion of the small number of birds which lost their bands as noted above.

Total number of birds = 3,343.

Number of *barred* birds = 3,007.

Number of *self-colored* birds = 336.

Total number of eliminated birds = 325.

Number of *barred* birds eliminated = 290.

Number of *self-colored* birds eliminated = 35.

The above figures include *all* eliminated birds, those killed by recorded and unrecorded enemies together. If we take only those killed by recorded enemies, which

⁴ See Pearl, R., and Surface, F. M., "On the Inheritance of the Barred Color Pattern in Poultry," *Arch. f. Entwicklungsmech.*, Bd. XXX, Fest-Band für Roux), pp. 45-61, 1910.

under the conditions prevailing on the plant in 1909 means practically those killed by rats, we have:

Number of *barred* birds eliminated by recorded enemies = 68.

Number of *self-colored* birds eliminated by recorded enemies = 6.

From these figures the following proportions are derived: Of the *total number* of birds 10.05 per cent. were *self-colored*.

Of all the *eliminated* birds 10.77 per cent. were *self-colored*.

If we consider by themselves the birds eliminated by recorded enemies, we have:

Of the birds *eliminated by recorded enemies* 8.11 per cent. were *self-colored*.

Putting the figures in another way we have:

Of the *self-colored* birds 10.42 per cent. were eliminated by *all* enemies.

Of the *barred* birds 9.64 per cent. were eliminated by *all* enemies.

Of the *self-colored* birds 1.79 per cent. were eliminated by *recorded* enemies (chiefly rats).

Of the *barred* birds 2.26 per cent. were eliminated by *recorded* enemies.

Of the *self-colored* birds 8.63 per cent. were eliminated by *unrecorded* enemies (chiefly predaceous birds).

Of the *barred* birds 7.38 per cent. were eliminated by *unrecorded* enemies (chiefly predaceous birds).

The conclusion to be drawn from these figures, which involve a large number of individuals, is obvious. It is that *the relative inconspicuousness of the barred color pattern afforded its possessors no great or striking protection against elimination by natural enemies, during the season (April 1 to October 1) of 1909 on the poultry range of the Maine Experimental Station*. It might be objected that if the eliminations by predaceous birds alone could be separately recorded it would then be found that against this class of enemies the barred pattern had

great protective value, as suggested by Davenport's figures. This, however, can hardly be the case in the present statistics since if it be assumed that predaceous birds killed relatively few barred chicks and relatively many self-colored, then it must also be assumed that the other unrecorded enemies showed a *preference* for barred birds, since with all enemies taken together substantially equal proportions of both kinds of birds were eliminated. In other words, if we assume a selective elimination in the case of predaceous birds, we are obliged to assume an *equal* and *opposite* selective elimination on the part of other unrecorded enemies. There is no evidence on which such an assumption could be based.

These figures, of course, cover only one year's experience, and are in no wise conclusive, but general observation indicates strongly that essentially the same result would be shown in other years if it were possible to tabulate the figures. Unfortunately neither the records of 1908 nor 1910 can be used for this purpose. In 1908 there were almost no self-colored birds on the range. In 1910, owing to the location of the houses on the range and other circumstances which can not be gone into in detail, thieves were active on the plant and the birds taken were not a random sample of the flock in respect to color. 1909 was a fortunate year for such a study as the present one. The thieves confined their attention to adult stock on a part of the plant away from the chicks, and left the latter strictly alone.

Definitely controlled observations regarding the elimination of animals by natural enemies, covering a considerable number of individuals and anything like a complete range of enemies, are exceedingly scarce. The whole question of the interplay of factors in the "struggle for existence" constantly going on in the organic world has been discussed very largely from the *a priori* standpoint, throughout the whole period since the appearance of the "Origin of Species." The "rabbit with his legs a little longer," the "fox with the little keener

sense of smell," the "bird of dull colors which harmonized with the background," *et id genus omne*, have been made to do valiant service.

Ever since the first description, made by the Nuremberg miniature painter Rösel in 1746,⁵ of a case of presumably protective coloration, we have been prone to argue that because an organism was colored or formed in such a way as to be inconspicuous it was, therefore, necessarily *protected* from attack by its enemies to a greater or less degree. The logic of such reasoning is flawless. It *ought* to be protected. But a conclusion may be perfectly logical and still not true. In the study of protective coloration, including mimicry, it is essential that a discovery that an organism is to human eyes inconspicuous or not readily distinguishable from some other organism shall not be considered the final goal. Rather let such a discovery always be supplemented by an experimental or observational determination of whether this inconspicuousness really helps the organism, in actual practise, in avoiding elimination by natural enemies. It is worth noting that more than one recent critical student of these problems who has applied this method has brought to light results essentially similar in their general import to those set forth here.⁶

⁵ Cf. Müller, H., "Schützende Aehnlichkeit einheimischer Insekten," *Kosmos*, Jahrg. III, Heft 8, p. 114, 1879.

⁶ Cf. for example the chapter on "Colouration of Organisms" in Dewar and Finn's "The Making of Species" (New York, 1909), and still more recently the thorough critical study by Punnett on "Mimicry in Ceylon Butterflies, with a Suggestion as to the Nature of Polymorphism" (*Spolia Zeylonica*, Vol. VII, Part XXV, September, 1910, pp. 1-24, 2 plates).